Code 588 Research Activities and Other Matters II

July 26, 2000

Walt Truszkowski
Senior Technologist
Advanced Architectures and Automation Branch
Code 588
301-286-8821
Walt.Truszkowski@gsfc.nasa.gov

Organization

Basic IS Technology Research: W. Truszkowski

- **TSA**
  - **Technology Information Website and Informtion Dissemination - L. Hull**
  - **TSA-related Research - W. Truszkowski**
- **Agent Technology**
  - **Agents Concepts Testbed - Truszkowski**
  - **Agent-related Studies - Truszkowski**
- **Usability Engineering**
  - **University HCI Studies - Dana Uehling**
- **Advanced Visual Tools and Architectures**
  - **Visualization Studies - Barbie Medina**

Agenda

- Technology Scanning and Assessment (TSA)
- Agent Technology R&D
- User Interface/Usability Research
- Other Activities
- Students/Teacher
- Summer Faculty
- Papers
- The Future

TSA's Concept and Goals

The purpose of the Technology Scanning and Assessment (TSA) activity is to provide a ready source of information on a range of technologies of current (and future) interest to Code 588 in particular and Code 580 (ISC) and AETD in general.

The challenges:

- **do not duplicate what is already available**
- **provide an organization of the information**
- **provide value-added commentary**
- **provide pointers to detailed information**

and

- **support research to help automate the information access and management process**

TSA's Team

GSFC - Code 588

Larry Hull
Chris Rouff
Walt Truszkowski (Overall Management)
Nigel Ziyad

Booz Allen and Hamilton

Rachel Campbell

GSFC - Library

Charlene Malloy

TSA Organization

Current TSA activities are divided into two major areas:

- Technology Intelligence Center - L. Hull
- TSA Research - W. Truszkowski

What is the TIC?

- Ensures technology awareness
  - Emerging technologies
  - Major existing technology developments
- Contributes to strategic and operational planning
  - Ensures state-of-the-art information systems
  - Supports NASA/GSFC mission success

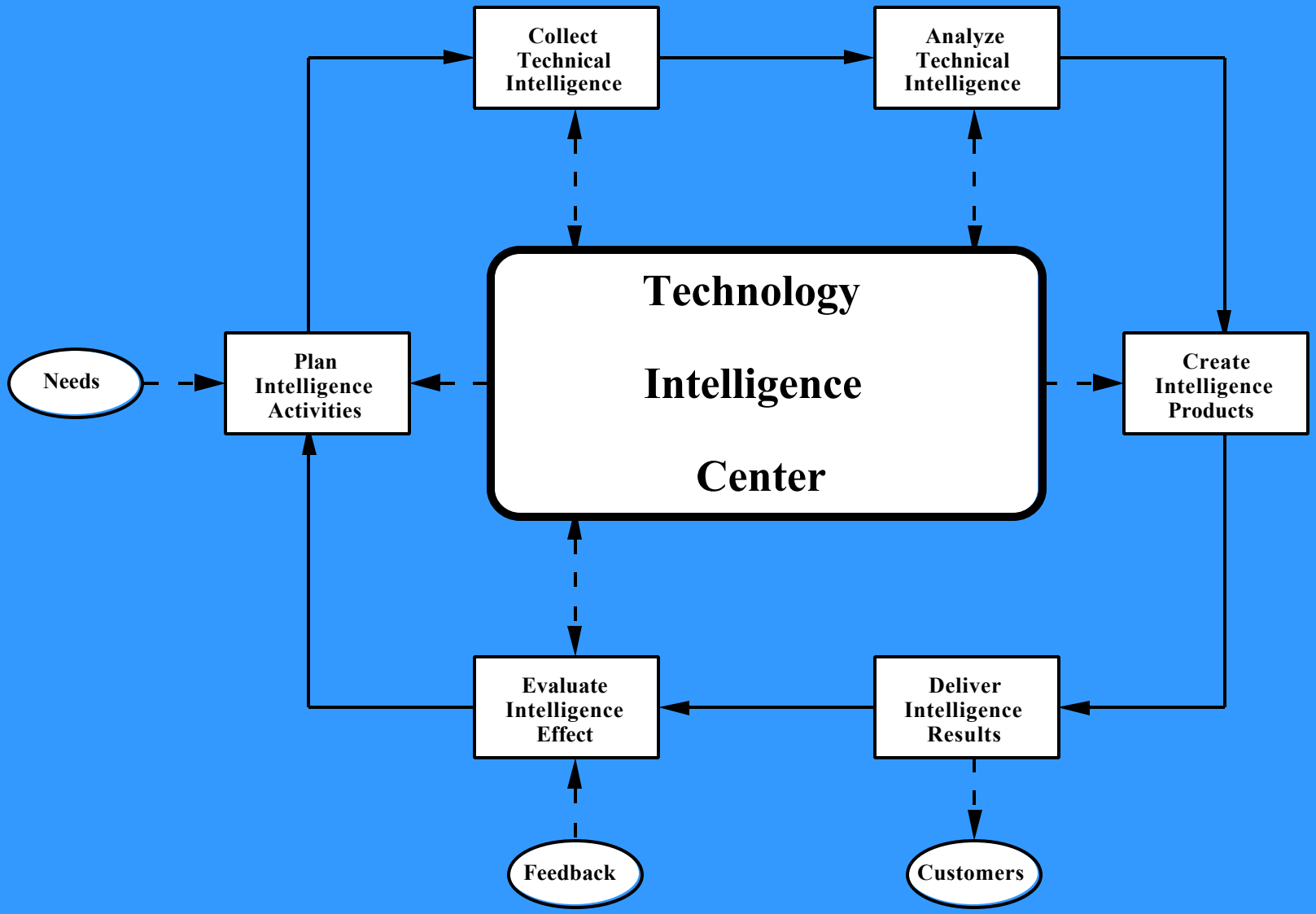
Who is the TIC

- Larry Hull - Lead Technology Researcher
- Nigel Ziyad - Technology Researcher
- Chris Rouff - Technology Researcher
- Rachel Campbell - Web Administrator
- Walt Truszkowski - Senior Technologist
- Charlene Malloy - Library Representative

Objectives

- Ensure technology awareness of both information system managers and developers
  - Emerging (new) technologies
  - Major developments in existing technologies
- Assist projects to incorporate technology advances into their information systems
- Provide technology overviews, expert opinions, and evaluations

Technology Intelligence Process



TIC

Library's Role

- Provide information resources to support and enhance TIC products and services
  - Newsletters
  - **Subject** Guides

    http://library.gsfc.nasa.gov/SubjectGuides/SubjectGuides.htm
  - Electronic Journals
  - Technology Databases
- Provide library representative to TIC

Current Products

- ISC Conference Calendar
- Gartner Group Service & Products
  - Newsletters
  - Research Reviews
  - Talking Tapes
  - GartnerWeb

Future Products

- Web Site
  - Technology Newsletter
    - Current Issue
    - Search Archive
  - Technology Report
    - Request Report
    - Search Existing Reports
  - Internet Search Tips
  - Library Links

TSA Research

TSA Research Group:

- Walt Truszkowski/588 - Lead
- Chris Rouff/588
- Larry Hull/588
- Jay Karlin/Viable Systems
- Sidney Bailin/Knowledge Evolution
- Jeff Hubona/Virginia Commonwealth

TSA Research Activities

There are two activities underway:

- Agent-based Information Mining
  - Reticular Systems
  - Purpose is to provide an agent-based system to support the mining of new information on agent technology from selected web sites

- Human Factors of Web Sites
  - Dr. Jeff Hubona - Virginia Commonwealth
  - This task involves designing and working with a conceptual prototype of the planned internet-based Technology Scanning and Assessment (TSA) system

Agent Research and Development

Why Agent R&D?

- Agent Technology is here to stay. We want to be innovators and influence the direction of this major technology area.

- The potentials for application of agent technology to realize ground-based and space-based systems autonomy are steadily growing. Our current efforts will position us to make real contributions to future missions.

Cast of Characters (Agent Group):

GSFC
- Tom Grubb
- Chris Rouff
- Walt Truszkowski

(Consultants)
- Troy Ames
- Carl Hostetter

AI Solutions
- Bob Spearing
- Nick Netreba
- Don Ginn

Towson University
- Barin Nag

Viable Systems Inc.
- Jay Karlin

Bowie State
- S. Srivastava
- James Gill de Lamadrid

UMBC
- Victoria Yoon

Knowledge Evolution
- Sidney Bailin

James Madison
- James Pomykalski

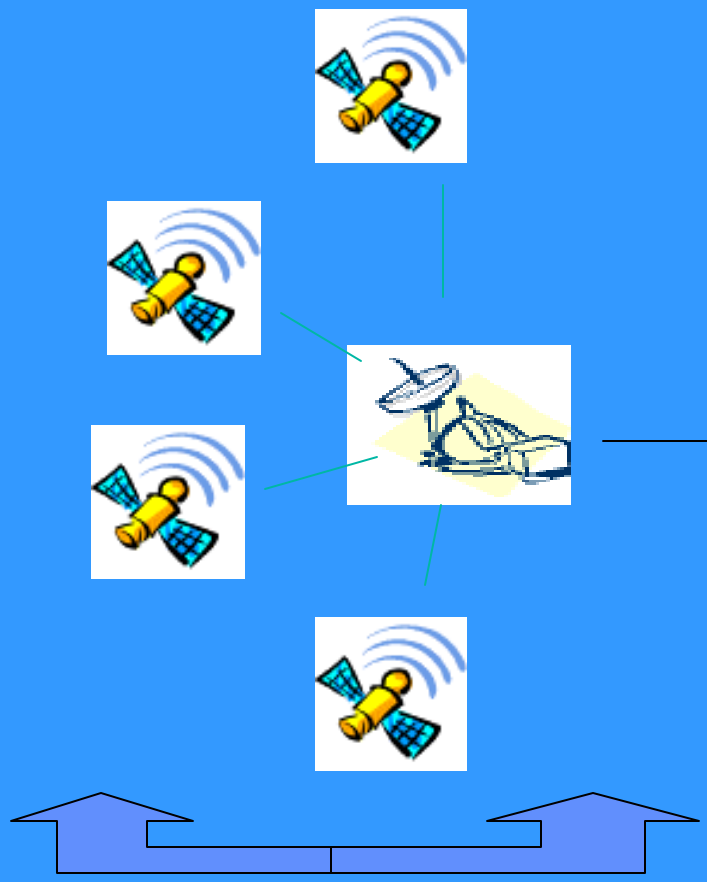
Agent R&D Topics:

- Agent Concepts Testbed (ACT)
- Autonomy Laboratory (AL)
- Remote Agent
- DDF Activity

Special agent-related studies:

- Ontology Negotiation
- Agent Learning
- Agent planning/scheduling
- Modeling
- Distributed Planning/Scheduling
- Agent Community Design
- Agent Formalization

Agent Concepts Testbed (ACT)



Mission Manager Agent

Contact Manager Agent

S/C Proxy 1 Agent

S/C Proxy N Agent

Community Visualization

Agent Concepts Testbed (ACT)

The demonstration system in the ACT highlighted the following:

- constellation management scenario
- agent communication language based on the FIPA Standard ACL
- agent and agent-community dynamics visualizations
- component-based agent architecture

Agent Concepts Testbed (ACT)

ACT Documentation

- Agent Architecture and Requirements Document
- Agent Architecture and Community Design Document
- Agent Communication Language
- Build 1 Requirements
- Component Framework Architecture User's Guide

Autonomy Laboratory (AL)

The purpose of the AL activity is to provide, to autonomy researchers here at GSFC and elsewhere. an environment for:

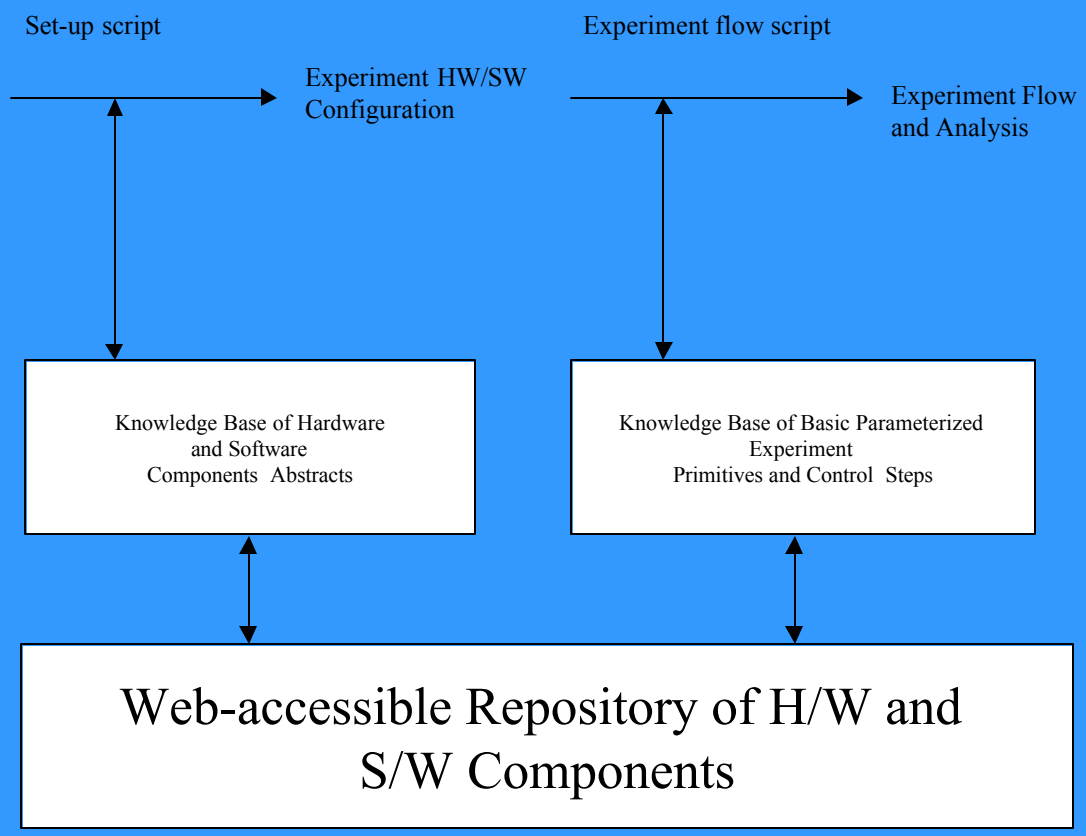
- carrying out experiments relating to cooperation among agents in getting a job done
- demonstrating new cooperative behavior techniques

Cooperation may be either:

- coordination, where one agent has authority over other supporting agents, or
- collaboration, where agents interact as peers

(Note: Cooperative behavior may involve both coordination and collaboration)

Autonomy lab (AL) Concept



Major components of the AL toolkit
- Repository of hardware and Software Components
- Repository of Basic Parameterized Experiment Primitives and Control Steps
- Set-up Scripting language
- Experiment Flow Scripting language

The AL Team

GSFC - Code 588

Walt Truszkowski

AppNet - Century Division

Steve Parr
Carl Cornwell

Status: - Revised AL concept documented
- Project on hold

Remote Agent

The objectives of this activity are to:

- study spacecraft systems to determine autonomy potentials

- develop and document approaches to agent-based spacecraft autonomy.

Remote Agent Team

GSFC

Lou Hallock/Code 585
Chris Rouff
Walt Truszkowski - Head

Viable Systems, Inc.

Jay Karlin

Remote Agent Activity

Status:

- Released Draft 1 of the report entitled: "Agent-based Spacecraft Autonomy"

- Work is underway on Draft 2 of the report

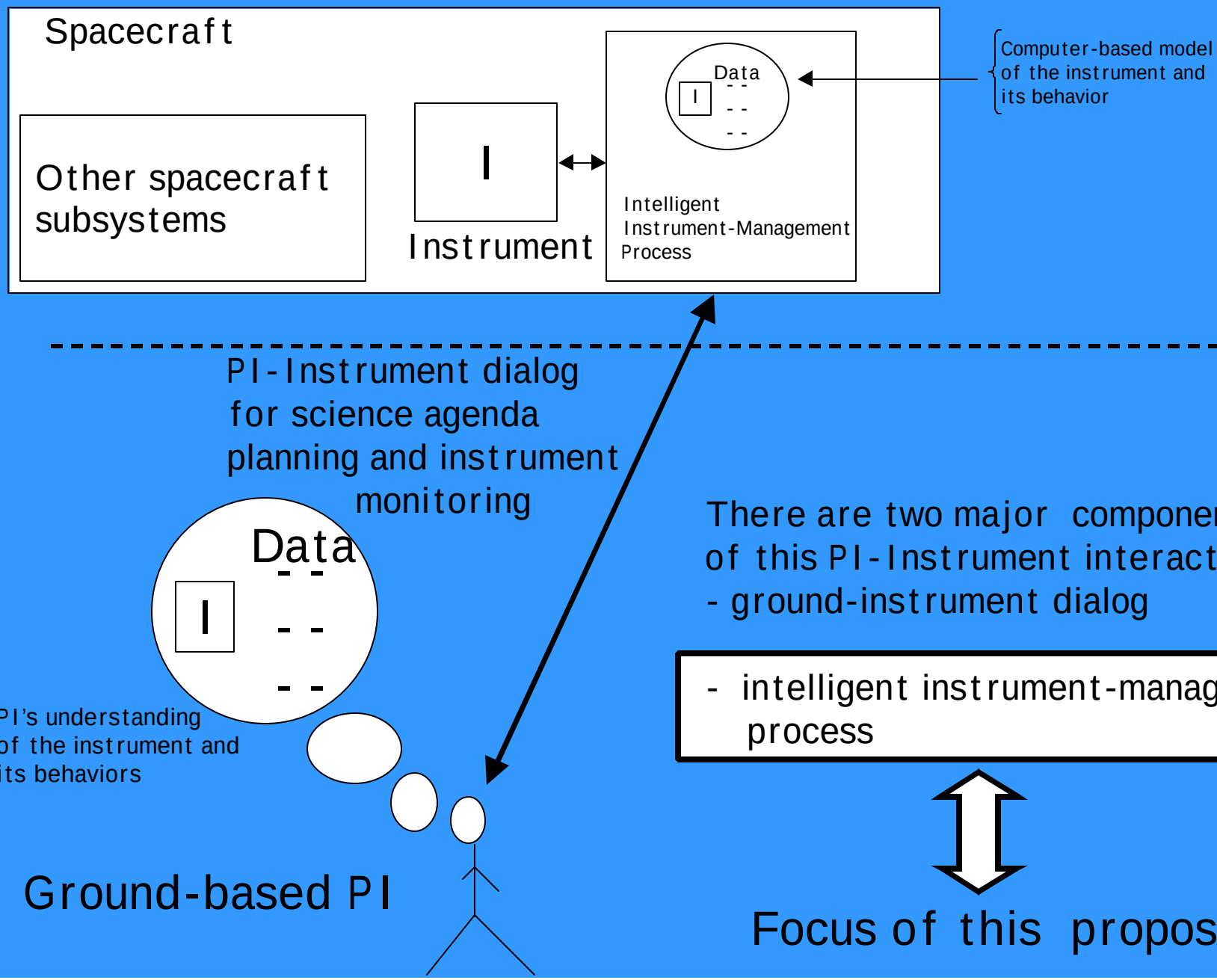
DDF

Objective: The objective of the DDF activity is to demonstrate the feasibility of a model-based approach to autonomous instrument operations.

The testbed for the demonstration is the LENA (Low Energy Neutral Atoms) instrument on IMAGE

Players: Mike Johnson/562
Dr. Mike Rilee/Ratheon
Walt Truszkowski/588
Tom Terenyi (Summer student)
Dr. Sidney Bailin (soon to come aboard)

DDF - Concept


Spacecraft
Other spacecraft subsystems
I
Instrument
Data
I
Intelligent Instrument-Management Process
Computer-based model of the instrument and its behavior
PI-Instrument dialog for science agenda planning and instrument monitoring
Data
I
PI's understanding of the instrument and its behaviors
Ground-based PI
There are two major components of this PI-Instrument interaction:
- ground-instrument dialog
- intelligent instrument-management process
Focus of this proposal

Special Studies

The purposes of the special studies are:

- to allow us to develop insight and competence in advanced topics which will play a role in our future applications of agent technology for autonomous operations

- to take advantage of R&D opportunities afforded us by our current activities in agent-related technologies

Special Studies - Ontology Negotiation

Two Important concepts

Ontology: Concepts and relationships among concepts used to reason about, understand and communicate about entities in a domain.

Knowledge Community: a community whose members continually reflect on their actions in order to learn from the results of same, and then make this new knowledge an asset of the community as a whole.

Ontology Negotiation

- Implemented a testbed which highlights an ontology negotiation protocol realized through a state machine and processing operators
- Demonstrated using multiple Earth science archives, each represented by an agent

Principal Investigator: Dr. Sidney Bailin
Knowledge Eolution, Inc.

Special Studies - Agent Learning

The purpose of this activity is to provide some direction for incorporating learning concepts in the new agent architecture.

Status:

- Ongoing

Principal Investigator: Dr. James Pomykalski
James Madison University

Modeling

The purpose of this activity is to help clarify the role that models and model-based reasoning will pay in our agents. Currently we are considering four classes of models for each agent:

- models of the environment in which the agent exist
- models of other agents in the community
- models of external resources
- model of the agent itself

Status: An initial status report on this work has been developed. A study of modeling languages is continuing.

Principal Investigator: Victoria Yoon
UMBC

Special Studies - Distributed Planning/Scheduling

The following scenario is being investigated:

A goal and deadline for a science objective is established for a set of spacecraft agents. The goal is decomposed through interactions among the agents in the set. Each spacecraft agent then performs its own planning/scheduling, decomposing it's individual goal into a set of sub-goals to be achieved in cooperation with other spacecraft agents to meet the science objective.

Special Studies - Distributed Planning/Scheduling

Status:

- Phase II commenced (May, 99). Objective is to develop a full-scope prototype system.

Principal Investigator: Subrata Das
Charles River Analytics

Agent Community Design

The intent of this activity is to establish a community architecture that supports such concepts as:

- dynamic populations
- cooperation regimes
- inter-agent dialogs
- inter-community interactions
- interactions with the “outside world”

Status: Draft community architecture concepts developed and under study. Agent community requirements being developed.

Principal Investigators: Jay Karlin - Viable Systems, Inc.
DR. Barin Nag - Towson University

Agent Formalization

- Formalized LOGOS System using CSP (with Mike Hinchey)
- Started formalizing communications between Agenda and Executive components of ACT agent architecture (with Lori Collins)
- Working with AST to use semi-formal methods to model ACT architecture
- Starting to work on formal methods tools to ease and speed up formalizations

This work is lead by Chris Rouff with support from Jim Rash

Workshop

A workshop on "Formal Approaches to Agent-based Systems" was held at GSFC in April, 2000.

- **sponsored by GSFC, NRL, DARPA**
- **organized by:**
  - **Jim Rash, Chris Rouff, W.Truszkowski, GSFC**
  - **Diana Gordon, NRL**
  - **Mike Hinchey,** University of Nebraska-Omaha
- 8 countries represented
- proceedings to be published by Springer-Verlag as a lecture Note in Computer Science
- A Kluwer book and special issues of Kluwer journals in the planning

User Interface Research

Zoomable User Interfaces

- Working with Ben Bederson of HCIL at UMD
- Investigating applying ZUIs to the Avatar project
- Have developed three paper prototypes
- Have started developing two of the three paper prototypes
- Will investigate interating the ZUIs into Avatar and compare with other visualizations techniques

This work is being directed by Chris Rouff

Usability Research

Usability Engineering Support Tools

- **Researchers at Virginia Tech (Rex Hartson et. al.) are building and evaluating a suite of usability engineering support tools. These tools are all inter-related, sharing a common database. The project includes tools for:**
  - **usability problem inspection,**
  - **usability problem classification,**
  - **usability data analysis,**
  - **usability data maintenance, and**
  - **usability engineering project management.**

This work is being directed by Dana Uehling

Other Activities

These activities fall under the Senior Technologist mantle:

- Esteblished an Associate Membership in the Foundation of Intelligent Physical Agents (FIPA)
- Serves on the Board of Advisors for an NSF Grant with Bowie State University
- Serves as GSFC Manager for one SBIR Subtopic
  - Autonomous Systems
- Serves as Member of GSFC S/W of the Year Panel
- Serves as Member of the NASA S/W of the Year Selection Panel
- Member of the GSFC DDF Review Panel
- Was elected to the Autonomous Systems Technical Committee of the AIAA
  - attended the general meeting in Reno, Jan 2000

Students/Teacher

Jeff Hoff

- Bishop Ahr High School
  Edison, NJ
- Project: develop new
  web page for the agent R&D
- see the work in progress at
  http://agents.gsfc.nasa.gov

Adit Koolwal

- Stanford University
  Palo Alto, CA
- Project: develop planning
  and scheduling concepts for
  the P/S component in our
  agent architecture
- Status: on-going

Students/Teacher

Dion Vigil

- University of NM
- Project: develop concepts for the reasoning component in our agent architecture
- Status: gave presentation to Joe Hennessy on 7/25

Merlene Leaphart

- Rudolph Elementary Washington, DC
- Project: develop lesson plan for her 6ht grade on agent technology
- Status: will complete project this Friday 7/28

Students/Teacher

Lori Ann Colins

- Hampton University
  HAMPTON, va
- Project - help formalize the communication between the Agenda and executor components in the agent architecture
- Status: on-going

Tom Terenyi

- University of Md
  College PARK, md
- Project - develop some LENA-related models
- Status: working on the development of low-voltage and high-voltage sub-models

Summer Faculty

Dr. Mike Hinchey - University of Nebraska-Omaha

- Working on completing the procedings from the very successful GSFC International Workshop on "Formal Foundations of Agent-based Systems' held here in April, 2000

- to be a Springer-Verlag Lecture Note in Computer Science

- Working with Jim Rash and Chris Rouff on an approach to a formal life-cycle methodology for the generation of correct operational systems

- a patent may be in the offing

Some Recent Publications

"Autonomy for Constellations", Walt Truszkowski GSFC. Dave Zoch, Dan Smith, Lockheed Martin, SpaceOps 2000

"Cybernetic Modeling of Agent Communities", Walt Truszkowski, GSFC, Jay Karlin, Viable Systems. CIA'2000 Workshop, Boston, MA

"Experience Using Formal Methods for Specifying a Multi-Agent System", Chris Rouff, James Rash, GSFC, Mike Hinchey, University of Nebraska-Omaha, IEEE International Conf. on Engineering of Complex Computer Systems, Kyoto, JP

"Satellite Constellation Support- Looking Towards New Architectures", Dan Smith, Lockheed Martin

Some of the Future

- Continue with current R&D activities
- Develop a community of agents for the SOHO Mission
  - will complement our agent research with a real-world application
- Begin work on a recent CIO award for "Automatic Categorization of Project Documents from Archives"
  - this is a project with the Goddard Library, STACC, and JPL
- Complete Phase I of the DDF work
- Begin work with a new RRA, Steve North
  - he will be working with the agent group
  - he is scheduled to arrive in Jan. 2001
- Begin work with students from WPI
  - they will be arriving in August